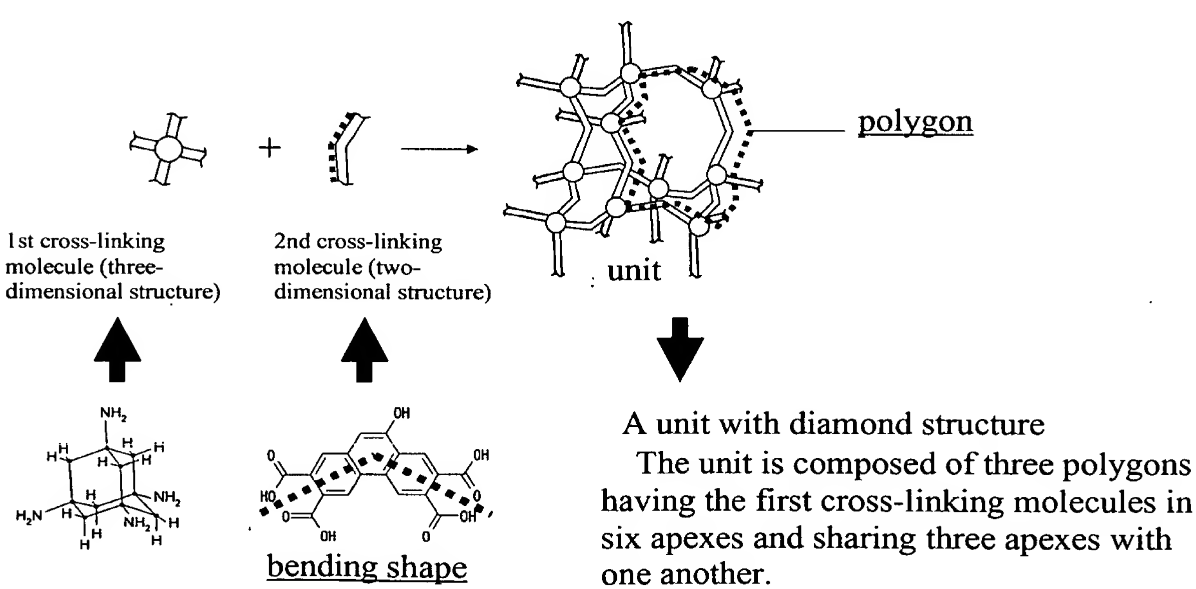
REMARKS

The Examiner's final Office Action dated June 24, 2003 has been received and its contents carefully noted. Initially, the Applicant wishes to thank Examiners Toledo and Fourson for the courtesies extended during the personal interview with the Applicant's representatives on September 24, 2003.

The Applicant respectfully submits that this response is timely filed and fully response to the Office Action. By the above amendments, claims 7, 8, 9, 18, 20, 22, 23 and 24 have been amended, claims 1-4, 6, 10 have been canceled and new claims 25 and 26 have been added. Consequently, claims 7-9, 13 and 18-26 are currently pending and of which claims 18, 20, 22-26 are independent. In light of the above amendments and detailed arguments to follow, reconsideration of the currently proposed rejection is respectfully requested.

The Examiner's indication that claims 20, 22 and 23 would be allowed if properly amended to include all the limitations of the base claim and any intervening claim is greatly appreciated. Accordingly, the Applicant has amended claims 20, 22 and 23 to include the limitations of the base claim (i.e., independent claim 18 of the Amendment of April 21, 2003 and the intervening claims 19 and 21). Therefore, allowance of claims 20, 22 and 23 is respectfully requested.

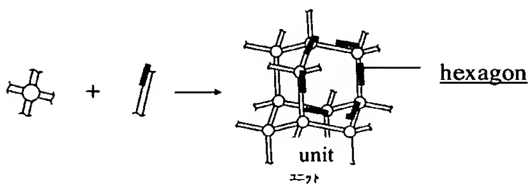
Support for the added claims 25 and 26 can be found in the specification at least at Embodiment 2 (pages 27-32) and can be shown for claim 25 as follows:



That is, claim 25 is slightly broader than the allowed claim 20 as follows:

Claim 20 (allowable)

Claim 25 (New claim)



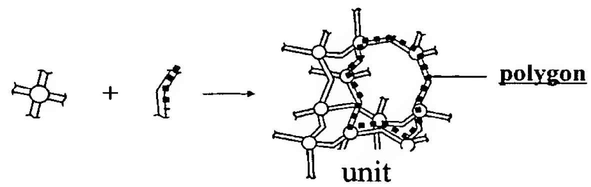


Figure 1A

Figure 1A Figure 9B

similarly claim 26 is slightly broader than allowed claim 22 as follows:

Claim 22 (allowable)

Claim 26 (New claim)

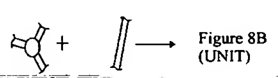


Fig 8(a)
(first cross-linking molecule)

Fig 2(b)
(second cross linking molecule)

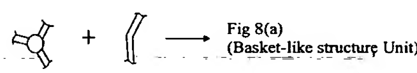


Fig 8(a)
(first cross-linking molecule)

Fig 9(b)
(second cross linking molecule)

With regard to the rejection of claims 6-18 [*sic 6-10, 13, 18, 19, 21 and 24*], under 35 U.S.C. 102(b), as being anticipated by the teachings of Brown et al. ('113), this rejection is respectfully traversed.

The present invention as set forth in independent claim 18 sets forth the method of forming a semiconductor device by the following:

> polymerizing a plurality of first cross-linking molecules each having a three-dimensional structure and a plurality of second cross-linking molecules each having a two-dimensional structure to form an interlayer dielectric film composing a three-dimensionally polymerized organic polymer,

> wherein, during polymerization, each first cross-linking molecule comprises a first organic molecule having attached thereto three or more functional groups, and each second cross-linking molecule comprises a second organic molecule having attached thereto two sets of functional groups, and
>
> wherein, upon polymerizing, each functional group of the first cross-linking molecules is bound to one functional group of a second cross-linking molecule and each function group of the second cross-linking molecules is bound to one functional group of the first cross-linking molecule to form a three-dimensional polymerized organic polymer structure having a plurality of molecular level pores. (Emphasis added)

In the prior art discussed in the specification, page 2, line 11, to page 3, lines 23, when an organic polymer film usable as the interlayer dielectric film of VLSI is porous, the relative dielectric constant of the film is lowered. However, a porous interlayer dielectric film has the problem in that the mechanical strength, the thermal resistance, and the adhesion to a substrate of the interlayer dielectric film are also lowered. To solve the above mechanical strength, thermal resistance and adhesion problems, the method for forming the semiconductor device in the present invention (independent claim 18) includes the step of forming the interlayer dielectric film to have a three-dimensionally polymerized organic polymer structure having a number of molecular level pores within the polymer structure.

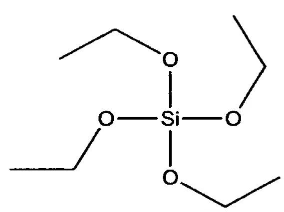
The Examiner, in setting forth the teachings of the Brown reference as related to the claimed invention, does not specifically identify, in any previous office action, which of the organic polysilica and polyamic ester terminated monomers of Brown (used to make the dielectric material) are to be considered the "first cross-linking molecules each having a three-dimensional structure" and the "second cross-linking molecules having a two-dimensional structure". Therefore, while it is difficult to respond to the broad assertion, in the final Office Action of June 24th, by the Examiner that Brown "...discloses polymerizing first cross-linking molecules having a three dimensional structure and second cross-linking molecules having a two-dimensional structure to form an interlayer...," a detailed review of the teachings of Brown reveals that the dielectric insulator of Brown is not formed by the polymerization described in independent claim 18.

Specifically, Brown (see particularly column 3, lines 1-8, 41-67; column 4,

lines 1-35; column 6, lines 56-67; column 7, lines 12-45) teaches an integrated circuit device having a metal wiring layers and including a dielectric material, which functions as an interlayer insulating film. The dielectric interlayer is formed by reacting monomers of organic polysilica and a polyamic ester terminated with a silane in a two-step process of:

> performing a chain extension and imidization of the polyamic ester by heating at a first time and temperature, e.g., 2 hrs, 200 C°, and then
>
> performing cross condensation of the functionalized polyimide with the polysilica by heating at a second time and temperature, e.g. 2 hrs, 400 C°, (see column 7, lines 25-45).

This process of Brown, using the reactants specified, cannot form the an interlayer dielectric film composing a three-dimensionally polymerized organic polymer of claim 18 where the first and second cross-linking molecules are bonded as specified. That is, the assuming 1) the polyamic ester terminated with a silane, i.e., such as the preferred alkoxysilylalkyl end-capped polyamic ester spanning column 7 and 8, is the first cross-linking molecule having more than 3 sets of functional groups, i.e., the four NH groups and four CO_2Et groups, and 2) the organic polysilica compound, such as the preferred tetraethoxysilane ($Si(EtO)_4$), is the second cross-linking molecule having two sets of functional groups, i.e. (EtO), as shown below:



tetraethoxysilane

Then, the first step of the reaction (i.e., heating at 200 °C, 2 hrs.) described by Brown of heating the mixture of the organic polysilica and polyamic ester terminated with a silane, i.e., such as the preferred alkoxysilylalkyl end-capped polyamic ester spanning column 7 and 8, will result in the functional groups of the more than three functional groups of the alkoxysilylalkyl end-capped polyamic ester, i.e., the four NH groups and four CO_2Et groups, being involved (bonded) in the chain extension and imidization.

Therefore, when the cross condensation reaction of the second step (i.e.,

heating at 400 °C, 2 hrs.) is performed, at least some of the more than three sets of functional groups of the first cross-linking molecule will have been involved in the chain extension and imidization. The result is that at least some of the functional groups of the first cross-linking molecule will not bond to the functional groups of the second cross-linking molecule of the organic polysilica during the second cross condensation of the remaining functionalized groups of the initially formed polyimide (since some of the functional groups of the first cross-linking molecule will be bound during the chain extension/imidization of the first process step). Additionally, the first cross-linking molecules of the polyamic ester terminated with a silane will be bonded the each other, and the second cross-linking molecules of the organic polysilica will be bonded the each other since both the first and second cross-linking molecules have the alkoxysilyl (Si-OR) moiety. Consequently, the dielectric insulating layer of the Brown cannot meet the requirements of independent claim 18 that the first and second cross-linking molecule only by bound to the each other.

If the example above is reversed such the organic polysilica of Brown is the first cross-linking molecule and the polyamic ester terminated with silane is the second cross-linking molecule, the teachings of Brown still do not meet the claimed requirements since the second cross-linking molecule does not contain two sets of functional groups (instead the molecule has more than three sets, i.e., four NH groups and four CO_2Et groups) as claimed and, further, the functional groups are not bound only to the functional groups of the first cross-linking molecule as claimed. Again, the dielectric insulating layer of the Brown cannot meet the requirements of independent claim 18.

If the Examiner is to maintain a rejection under § 102 (or set forth a new rejection under either § 102 or § 103) over the teachings of the Brown reference (or a new reference(s)), the Applicant requests that the Examiner point out in detail which molecules of the compounds disclosed in those references are considered to be the "first cross-linking" and "second cross-linking" molecules of the claims that are rejected. Such an elaboration will enable the Applicant to more precisely respond to those teachings, if the rejection is traversed.

Since Brown does not teach each and every feature of the presently claimed

invention the rejection, under § 102(b), cannot be maintained and should now be withdrawn. Further, since Brown does not provide any suggestion or motivation to modify the teachings therein to arrive at the presently claimed invention, a rejection under § 103(a) would also be inappropriate based upon the teachings of Brown.

While the present application is now believed to be in condition for allowance, should the Examiner find some issue to remain unresolved, or should any new issues arise, which could be eliminated through discussions with Applicant's representative, then the Examiner is invited to contact the undersigned by telephone in order that the further prosecution of this application can thereby be expedited.

Lastly, it is noted that a separate Extension of Time Petition (one month) accompanies this response along with a check in payment of the requisite extension of time fee. However, should that petition become separated from this Amendment, then this Amendment should be construed as containing such a petition. Likewise, any overage or shortage in the required payment should be applied to Deposit Account No. 19-2380 (740819-524).

Respectfully submitted,

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AMENDMENTS TO THE CLAIMS:

Please amend the claims as follows:

1.-6. (Cancelled)

7. (Currently Amended) The method for forming a semiconductor device film of Claim 18 ~~6~~, wherein the first organic molecules are represented by

$$\begin{array}{c} X_2 \\ | \\ X_1 \text{ --- } R_1 \text{ --- } X_1 \\ | \\ X_2 \end{array}$$

(where R_1 is a first organic skeleton, X_1 is a first set of functional groups, and X_2 is a second set of functional groups, X_1 and X_2 being same or different in type),

the second organic molecules are represented by

$$Y_1 - R_2 - Y_2$$

(where R_2 is a second organic skeleton, Y_1 is a third set of functional groups, and Y_2 is a fourth set of functional groups, Y_1 and Y_2 being same or different. in type),), and

wherein, during polymerization, the three-dimensionally polymerized organic polymer is formed by binding the first set of functional groups (X_1) and the third set of functional groups (Y_1) together and binding the second set of functional groups (X_2) and the fourth set of functional groups (Y_2) together, and

the molecular level pores are formed in regions surrounded by the first organic skeletons (R_1) and the second organic skeletons (R_2).

8. (Currently Amended) The method for forming a semiconductor device of Claim 18 ~~6~~,

wherein the first organic molecules are represented by

$$\begin{array}{c} X_1 \\ | \end{array}$$

$$
\begin{array}{l}
Z \text{ --- } R_1 \text{ --- } X_2 \\
\qquad\quad | \\
\qquad\quad X_1
\end{array}
$$

(where R_1 is a first organic skeleton, X_1 is a first set of functional groups, X_2 is a second set of functional groups, and Z is a third set of functional groups, X_1 and X_2 being same or different in type),

the second organic molecules are represented by

$$Y_1 - R_2 - Y_2$$

(where R_2 is a second organic skeleton, Y_1 is a fourth set of functional groups, and Y_2 is a fifth set of functional groups, Y_1 and Y_2 being same or different in type), and

wherein, during polymerization, the three-dimensionally polymerized organic polymer is formed by ~~first~~ binding the first set of functional groups (X_1) and the fourth set of functional groups (Y_1) together and binding the second set of functional groups (X_2) and the fifth set of functional groups (Y_2) together to form a plurality of units and then binding the third set of functional groups (Z) of the plurality of units together, and

the molecular level pores are formed in regions surrounded by the first organic skeletons (R_1) and the second organic skeletons (R_2) in the plurality of units.

9. (Previously Presented) The method for forming a semiconductor device of Claim 18, further comprising the steps of:

forming a surface barrier film on the interlayer dielectric film;

forming a mask on the surface barrier film;

forming a concave portion in the surface barrier film and the interlayer dielectric film by etching the surface barrier film and the interlayer dielectric film using the mask; and

forming an interconnection made of a metal material by filling the concave portion with the metal material.

10.-12. (Canceled)

13. (Previously Presented) The method for forming a semiconductor device of Claim 18, further comprising the steps of:

forming a mask on the interlayer dielectric film;

forming a concave portion in the interlayer dielectric film by etching the interlayer dielectric film using the mask;

forming a sidewall barrier film on sidewalls of the concave portion; and

forming an interconnection made of a metal material by filling the concave portion having the sidewall barrier film with the metal material.

14.-17. (Canceled)

18. (Currently Amended) A method for forming a semiconductor device, comprising the steps of:

polymerizing a plurality of first cross-linking molecules each having a three-dimensional structure and a plurality of second cross-linking molecules each having a two-dimensional structure to form an interlayer dielectric film composing a three-dimensionally polymerized organic polymer ~~having a plurality of molecular level pores~~,

wherein each first cross-linking molecule comprises a first organic molecule having attached thereto three or more functional groups, and each second cross-linking molecule comprises a second organic molecule having attached thereto two sets of functional groups, and

wherein, during polymerizing, each functional group of the first cross-linking molecules is bound to one functional group of a second cross-linking molecule and each function group of the second cross-linking molecules is bound to one functional group of the first cross-linking molecule to form a three-dimensional polymerized organic polymer structure having a plurality of molecular level pores.

19. (Previously Presented) The method for forming a semiconductor device of Claim 18, wherein the three-dimensionally polymerized organic polymer has a unit

with diamond structure.

20. (Currently Amended) <u>A method for forming a semiconductor device, comprising the steps of:</u>

<u>polymerizing first cross-linking molecules having a three-dimensional structure and second cross-linking molecules having a two-dimensional structure to form an interlayer dielectric film composing a three-dimensionally polymerized organic polymer having a number of molecular level pores,</u>

<u>wherein the three-dimensionally polymerized organic polymer has a unit with diamond structure</u> ~~The method for forming a semiconductor device of Claim 19,~~

~~wherein the unit with diamond structure is~~ composed of three hexagons sharing two sides with one another.

21. (Previously Presented) The method for forming a semiconductor device of Claim 18, wherein the three-dimensionally polymerized organic polymer has a basket-like unit.

22. (Currently Amended) <u>A method for forming a semiconductor device, comprising the steps of:</u>

<u>polymerizing first cross-linking molecules having a three-dimensional structure and second cross-linking molecules having a two-dimensional structure to form an interlayer dielectric film composing a three-dimensionally polymerized organic polymer having a number of molecular level pores,</u>

<u>wherein the three-dimensionally polymerized organic polymer has a basket-like unit</u> ~~The method for forming a semiconductor device of Claim 21, wherein the basket-like unit is~~ composed of three hexagons sharing two sides with one another.

23. (Currently Amended) <u>A method for forming a semiconductor device, comprising the steps of:</u>

<u>polymerizing first cross-linking molecules having a three-dimensional structure and second cross-linking molecules having a two-dimensional structure to form an</u>

interlayer dielectric film composing a three-dimensionally polymerized organic polymer having a number of molecular level pores ~~The method for forming a semiconductor device of Claim 7~~,

wherein the first organic molecules are adamantine derivatives, and the second organic molecules are benzene derivatives.

24. (Currently Amended) ~~The method for forming a semiconductor device of Claim 8,~~ A method for forming a semiconductor device, comprising the steps of:

polymerizing first cross-linking molecules having a three-dimensional structure and second cross-linking molecules having a two-dimensional structure to form an interlayer dielectric film composing a three-dimensionally polymerized organic polymer having a number of molecular level pores,

wherein the first organic molecules are benzene derivatives, and the second organic molecules are phenanthrene derivatives.

25. (New) A method for forming a semiconductor device, comprising the steps of:

polymerizing first cross-linking molecules having a three-dimensional structure and second cross-linking molecules having a two-dimensional structure to form an interlayer dielectric film composing a three-dimensionally polymerized organic polymer having a number of molecular level pores;

wherein the three-dimensionally polymerized organic polymer has a unit with diamond structure composed of three polygons having the first cross-linking molecules in six apexes and sharing three apexes with one another.

26. (New) A method for forming a semiconductor device, comprising the steps of:

polymerizing first cross-linking molecules having a three-dimensional structure and second cross-linking molecules having a two-dimensional structure to form an interlayer dielectric film composing a three-dimensionally polymerized organic polymer having a number of molecular level pores;

wherein the three-dimensionally polymerized organic polymer has a basket-like unit composed of two polygons having the first cross-linking molecules in six apexes and sharing two apexes with one another.